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ABSTRACT

Recent surveys on writing in secondary school science classes indicate that a variety of modes of writing are incorporated for different purposes. The critical essay, the research report, and term paper assignments still demonstrate their usefulness as promoters of learning science. The study guide, another standard teaching tool, also continues to be used effectively. Other creative assignments to involve students include: translating science text to newspaper format; personal narrative writing in response to science experiences; situation-based fiction; rewriting of technical material; and writing a dialogue dramatizing conversations about scientific developments. The most popular new arrival on the writing-to-learn scene is the student journal. The value of writing to learn in science extends beyond gaining knowledge of the subject to students acquiring understanding of themselves and their relation to the world, clearly a desired outcome of science instruction. (Contains 49 references.) (RS)

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Writing to Learn in Science

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Abstract

A review of recent surveys on writing in secondary school science classes describes the purposes and kinds of activities assigned. As promoters of learning science, the following are explored: the critical essay, the study guide, the journal, and a variety of creative assignments. Writing as a mode for learning content is advocated.

WRITING TO LEARN IN SCIENCE

"Writing is efficient: it works as learning. In labs., science teachers give students opportunities to learn science by experimenting with procedures and instruments. Writing can also let students experiment with concepts and processes. As they manipulate and test factual data on paper - as they write - they actively learn science." (Strenski, 1984, p. 61)

Writing in the content areas is gaining increased attention as its potential for promoting learning becomes clear. Since Applebee's classic surveys (1981, 1983) of the extent and types of writing being done in secondary school classes, other surveys have been conducted (Briggs et al., 1981; Tighe and Koziol, 1982; Knoblauch and Brannon, 1983; Stewart and Leaman, 1983; Pearce, 1984; Parker, 1985). Applebee summarized the kinds of writing being done as: writing without composing (e.g., short answers); informational uses of writing (e.g., note-taking, reporting, summarizing, analyzing); personal uses of writing (e.g., journal, letters); imaginative uses of writing (e.g., stories, poems, plays). Although 44% of class time involved writing activities, these tended to be mechanical (short answers rather than paragraph length or longer). Of the writing observed in science classes, 99% reflected informational uses of writing. When science teachers were

asked what reasons they had for asking their students to write, responses were of two kinds:

Stress on information versus personal experience:

- to test learning of content (72%)
- to remember information (67%)
- to summarize class materials (40%)
- to correlate experience with topic (12%)
- to express feelings (10%)

Stress on concepts versus skills:

- to apply concepts to new situations (60%)
- to force thinking (58%)
- to test clear expression (42%)
- to explore out-of-class material (24%)
- to teach proper essay form (14%)

Tighe and Koziol (1982) surveying teachers found that the types of writing assignments given in science in rank order were: note-taking, observation/recording of events, comparison/contrast of views, personal responses to reading, and summaries. Pearce (1984) noted that more than half the teachers responding to his survey ranked the most common types of writing in science as answering review questions and essay questions. Thus the traditional view that writing occurs in English classes only or that writing in other subjects is limited entirely to expository writing in the form of reports or research essays is no longer accurate. Instead, a variety of modes of writing is incorporated for different purposes. This has resulted in part from the realization by teachers and researchers that writing and reading are naturally integrated, and, therefore, experiences

with one mode complement learning in the other mode. Furthermore, teachers have to some extent recognized that their responsibility for teaching content can best be served by providing students with the skills needed to learn the content, thus promoting the goal of the independent learner. As Licata (1980) noted, "If science educators are to continue to assert that science is a basic in today's world, and if achievement of scientific literacy goes hand in hand with that of overall literacy, then I believe we must do everything in our power to help students to learn science - and that includes teaching reading and writing." (p. 24)

Specifically, what are some of the writing activities presently being used in science classes? The critical essay, research report, term paper assignments are by no means out-dated as many sources describe their usefulness (Carlisle, 1978; Fagan, 1978; Ross and Jarosz, 1978; Rosenbaum, 1981; Wotring and Tierney, 1981). Newell (1984) in a study comparing the study guide, note-taking and the critical essay found the latter most effective in increasing learning of science content. Schumm and Radencich (1984), on the other hand, promote a workshop approach for writing a term paper which incorporates note-taking and outlining. Fincke (1982) advocates a guided procedure for writing a research paper. Topics for essays and reports are as varied

as the following examples: the impact of science and technology (Ellman, 1978); the results of a product research study or survey report (Lewis, 1978); an historical, analytical, descriptive, or biographical focus (Applebee, 1981).

Clearly, certain subskills are necessary to write an effective essay: abstracting, paraphrasing, outlining, note-taking, for example. Wilkinson (1985) concluded that the ability to abstract and summarize was useful for students writing scientific papers. One activity for developing the ability to summarize is precis writing. "In precis writing the student develops a paraphrased summary or abstract of a written composition, retaining the information and flavor of the original, but usually condensing to about one third its length." (Bromley, 1985, p. 407). The value of this kind of exercise is described by Boulanger (1983): "Paraphrasing requires the interrelationship of comprehension and expression skills, experience and memory, problem-solving and creativity." (p. 15).

Another standard teaching tool, the study guide, also continues to be effectively used. Langer (1986) sees the study guide as one element of effective study skills (the others are note-taking and essay writing). Tierney et al. (1985) also relate study guide questions to note-taking and

students' written discourse. Certain variations of the study guide have appeared such as pattern guides (Olson and Longnion, 1982), the framed paragraph (Santa et al., 1985); the directed writing activity (Robinson, 1983), and PORPE - Predict, Organize, Rehearse, Practice, Evaluate (Simpson, 1986). Note-taking itself can encompass different learning activities. Arthur (1981) describes note-taking in the science classroom as a response to listening to a lecture. Rubin (1983), on the other hand, sees it as integrated with reading science material. Strenski (1984) discusses note-taking as a review/study technique at the end of a unit; notes are converted to paragraphs which students share.

Other creative activities to involve students are: translating science text to newspaper format (Arthur, 1981; Tierney et al., 1985); letter writing about science or to scientists (Ellman, 1978; Singer and Donlan, 1980; Myers, 1984; Steinacker et al., 1984; Dittmer, 1986); and personal narrative writing in response to science experiences (Steinacker et al., 1984). Some examples of writing assignments are provided by Dittmer (1986):

1. Describe a familiar physical phenomenon with the reason for its occurrence; in a group, discuss your descriptions and assess the most effective; share with the class to improve; compare to a law which describes the phenomenon (e.g., gravity).
2. A fly infestation is sprayed with pesticide and

numbers drop. However, numbers later increase and do not drop when sprayed. Explain what you think has happened. Describe a similar situation using different facts. What test could you use to validate your explanation?

3. Select a general statement such as 'The smaller the organism, the larger are its energy needs'. List examples. Write a narrative to include this information.

Licata (1980) suggests such narrative, science-centered assignments as writing a tall-tale, situation-based fiction, a story based on a picture, and poetry. He also advocates factual writing: summary of a film or video or of a newspaper article or text chapter. Other interesting writing exercises are: produce an informational book on a scientific topic using a creative approach (Maxwell and Judy, 1978; Lehr, 1980); rewrite technical materials, directions or rules for a layperson or a younger student (Carlisle, 1978; Ellman, 1978; Shugarman and Hurst, 1986); write a mystery story depending on a scientific principle, a futuristic scenario, a poem about a scientific phenomenon e.g., fertilization, nuclear fusion, osmosis (Ellman, 1978); write a dialogue dramatizing conversations about scientific developments such as cities in space or issues like protection of endangered species (Wilkes, 1978). Carlisle (1978) describes an activity to incorporate different kinds of writing and learning:

Select an object in a science display. Write about it: in a detailed "objective" description (write it so that your reader can visualize it or experience it in some way, or even find it); in an impressionistic account (show your reader the thoughts and impressions stimulated by the subject); and in a narrative or story about it or based on it (imagine a situation that involves the subject or series of events that caused or made it or write the story of your own involvement with the subject).

The most popular new arrival on the writing-to-learn scene is the journal. Its widespread use has been explained by Fulwiler (1980): "A student's journal can be a documentary of both academic and personal growth, a record of evolving insight as well as the tool used to gain that insight." (p. 18). He describes the scope of the journal as "somewhere on a continuum between diaries and class notebooks: whereas diaries are records of personal thought and experience, class notebooks are records of other people's facts and ideas." (p. 17). Bowman (1983) sees the purposes of journals as to mirror the mind, to see and confront the self, as well as to surface academic considerations related to coursework. He claims that students gain personal control of their learning by fashioning questions and raising issues and concerns central to the coursework. "Student journals are particularly effective in shaping daily classroom activities to permit students to achieve more active, involved roles in the learning process". (Bowman, p. 26). Journals can be used to respond to a lab. experiment, demonstration, lecture,

or project (Carlisle, 1978; Singer and Donlan, 1980; Shadiow, 1981; Knoblauch and Brannon, 1983). Wotring and Tierney (1981) found that journal writing in science provoked students to reflect on their own thoughts, take responsibility for their own learning, and begin to raise and answer their own questions.

"One way to facilitate students' learning about a subject is to have them write, because learning and articulating are inseparable activities. Writing enables new knowledge because it involves precisely that active effort to state relationships which is at the heart of learning." (Knoblauch & Brannon, 1983, p. 467-8).

Advocates of writing to learn are abundant (Oliver, 1982; Petrosky, 1982; Slater, 1982; Knoblauch and Brannon, 1983; Pearce, 1983; Collins, 1985; Vacca and Vacca, 1986; to name a few). However, the most comprehensive resource is Haley-James (1982). Her seminal article deals with:

1. Why writing encourages learning (focusses thought, making thought available for inspection; allows more complex thought; translates mental images; is multisensory; motivates communication);
2. When writing is most likely to encourage learning (when students decide what to write about; when they talk as part of writing; when they view writing as a process; when they have their own reasons for writing; when they write frequently);

3. How teachers can link writing to subject matter (writing to gain access to what is known; writing to preserve and express ideas and experiences; writing to inform and persuade others; writing to transact business; writing to entertain).

Thus writing can serve many purposes. As a response to reading, writing can improve comprehension, thereby assisting students to handle textbooks effectively. Writing can also involve translation and application of what is read or heard, helping students to study, to do research, and to write tests. Perhaps most importantly, however, writing provides students the opportunity for self-expression, enabling them to react to the ideas and information they encounter. The value of writing to learn in science extends beyond gaining knowledge of the subject to acquiring understanding of oneself and one's relation to the world, clearly a desired outcome of science.

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